National Aeronautics and Space Administration

NASAfacts

Aviation Systems Division (Code AF) FY11 Technical Highlights

Air Traffic Management (ATM) Technical Demonstration (ATD)-1

In FY11, the Plan for the Agency's first ATM Technology Demonstration (ATD) was completed, and research efforts, including the development of a fast-time scheduling simulation tool, and the conduct of three terminal area precision scheduling system human-in-the-loop simulations, were accomplished in support of the plan. This first in a series of ATM Technology Demonstration activities for the Aeronautics Research Mission Directorate (ARMD) is aimed at accelerating airspace technology transition in general, and adoption of Automatic Dependent Surveillance – Broadcast technology in particular. ATD-1 will combine advanced time-based scheduling in terminal airspace, controller managed spacing tools, and flight deck interval management to achieve sustained fuel efficient operations during periods of high traffic demand. The effort includes coordination with the Federal Aviation Administration (FAA) and industry partners, as well as Ames and Langley research teams.

Ames Simulation Laboratories: SimLabs – Vertical Motion Simulator (VMS), Crew-Vehicle Systems Research Facility (CVSRF), and FutureFlight Central (FFC)

CVSRF simulations that utilized the air traffic control (ATC) laboratory, Boeing 747-400 simulator, and Advanced Concepts Flight Simulator (ACFS) piloted cabs included: Efficient Descent Advisor, Trajectory-Based Operations with air/ground datalink communication studies, and Emergency Landing Planner. VMS simulations included: The Boeing Speed Agile Concept Demonstrator concept aircraft, Control Allocation for Pilot-Induced Oscillation, a joint NASA-Army simulation on Large Civil Tilt-Rotor Handling Qualities, and an International Space Station fruit

ATD-1 shakedown simulation in the NASA Ames ATM Laboratory

Boeing 747-400 simulator and Advanced Concepts Flight Simulator in the CVSRF

flies experiment for the Biomodel Permanence and Behavior Lab and the Fluid Mechanics Lab. SimLabs also continued development of a full-scale turnkey flight simulator with an eye-limiting visual system to support the Air Force's Operational Based Vision Assessment system for clinical vision research on pilots.

To enable more robust and sophisticated simulations, SimLabs integrated new aerodynamics, flight controls, engine, and auto-pilot models in the ACFS to better emulate the Boeing 737-800. The FFC airport control tower simulator's networks and computers were improved to more realistically simulate surface traffic on radar displays and enable out-the-window visuals.

Efficient Descent Advisor (EDA)

The EDA research effort completed the final four in a series of seven human-in-the-loop simulations in support of technology transfer to the FAA under the 3D-Path Arrival Management research transition activity. All four simulations included participation from active duty controllers from the Denver En route Center and evaluated EDA under trajectory-prediction uncertainty, improved procedures; an active, radar-side conflict probe, mixed operations; and EDA against a baseline scenario.

UAV/UAS

In FY11, NASA's ARMD initiated the Unmanned Aircraft Systems in the National Airspace System (UAS in the NAS) project. A Navy-led Broad Area Maritime Surveillance (BAMS) System simulation was performed in the SimLabs' CVSRF, networking five participating facilities across the US to investigate the integration and safe operation of the U.S. Navy's BAMS UAS in the NAS. Efforts also led to the completed development of an initial UAS in the NAS modeling and simulation capability, designed to gather data on integrating UAS into the NAS, and the effect of equipping the UAS with the Traffic Collision Avoidance System-II capability. This system was successfully demonstrated in the SimLabs' Boeing 747-400 simulator and ATC laboratory.

Separation Assurance

Two major human-in-the-loop simulations supporting Separation Assurance were completed and promising results were gained from initial testing of the dynamic weather reroute concept. The first simulation evaluated the potential benefits of a trajectory-based automation system that integrates solutions for traffic conflicts, time-based metering and weather-avoidance, using air/ground datalink communication. The second set of simulations studied the use of datalink communication in a near-term, mixed-equipage environment, investigating strategic and tactical weather avoidance and new clearance procedures. The dynamic weather reroute concept integrated trajectory-based automation for Center radar controllers, convective weather modeling, and algorithms to automatically compute minimum-delay routes around weather cells. In a limited dataset, this new concept was found to save an average of 4 min. per flight when compared to the original flight plan, leading to potential savings of 350 min. flying time over 5 hours of weather-impacted operations in one En route Center. NASA and industry partners worked to integrate NASA trajectory automation with the FAA's En Route Automation Modernization system and Future Air Navigation System 1/A integrated Flight Management System/datalink into a field test system suitable for operational trials in the NAS.

Separation assurance researchers also achieved significant improvement in the area of climb trajectory prediction. Researchers were able to achieve a reduction in 5-min. climb prediction errors by as much as 90% in laboratory testing through a new technique

Simulation of Trajectory-Based Operations using datalink communications using the CVSRF's Boeing 747 flight simulator

NASA conducted studies on the trade-offs between fuel burn and contrail reduction using wind-optimal aircraft trajectories.

that is slated for integration into the Center TRACON Automation System trajectory predictor.

Super Density Operations

Researchers performed two sets of human-in-the-loop simulations to investigate the Terminal Tactical Separation-Assisted Flight Environment (T-TSAFE), a conflict detection and resolution (CD&R) tool. T-TSAFE will be integrated with the FAA's prototype Automatic Terminal Proximity Alert (ATPA) tool which detects compression errors in the final approach phase. The first simulation verified fast-time simulation results and investigated controller procedures and information requirements. The second set of simulations examined altitude-based resolutions and an expanded controller user interface, as well as the use of T-TSAFE conflict alerts alone versus in combination with ATPA on final approach. Both simulations also evaluated impact on controller workload, procedures, situation awareness and trust. Super density researchers also assisted the FAA with improving features within the operationally deployed Traffic Management Advisor (TMA).

Traffic Flow Management (TFM)

Environmental impacts due to aviation, specifically with regard to contrail formation and prediction, were researched and the Division's Senior Scientist for ATM presented these results on the trade-offs between fuel burn and contrail reduction using wind-optimal aircraft trajectories at the Partnership for Air Transportation Noise and Emission Reduction Advisory Board Meeting.

Researchers completed a successful operational shadow assessment of a model that calculates key Ground Delay Program (GDP) parameters for San Francisco International Airport. The operational assessment team demonstrated that the model-recommended GDP end times would have reduced overall delays by 14%, leading to a recommendation to conduct an operational evaluation of the system for the 2012 stratus season. In another FAA collaboration, a multi-year study that was designed to examine the interactions between the TMA and national-level traffic flow management initiatives, such as TMA Flow Programs (TFPs) and GDPs, was completed. This study investigated the impact of operating a TFP in conjunction with the TMA at the Hartsfield-Jackson Atlanta International Airport during taxiway construction in Fall 2010 and showed the potential imbalance in the delays assigned to flights that were included and exempt from the TFP.

Ames' credits-based system concept for airspace user preferences gained positive feedback from the Airline Dispatcher's Federation as a viable option for providing flight preferences, in conjunction with the FAA's Collaborative Trajectory Options Program. The credit assignment software developed at NASA was integrated in the FAA's System-wide Enhancements for Versatile Electronic Negotiation framework.

Under funding from the American Recovery and Reinvestment Act, a year-long research task to integrate a probabilistic convective weather product into the Future Air traffic management Concepts Evaluation Tool (FACET) was completed. The task developed the capability to acquire Localized Aviation Model Output Statistics (MOS) Program (LAMP) data, which produces probabilistic maps of forecasted convective activity up to 24 hours in advance, and compute national airspace capacity estimates.

Surface Research

In the airport surface domain, researchers completed analyses of a FY10 simulation that investigated surface scheduling algorithms in a human-in-the-loop simulation. These results were summarized in a paper presented at the 2011 USA/Europe ATM R&D Seminar.

The paper described results from the simulation evaluation of the Spot And Runway Departure Advisor (SARDA) decision support tool.

Precision Departure Release Capability (PDRC)

A field evaluation of PDRC was completed in collaboration with the FAA, American Airlines, and Dallas/Ft. Worth (DFW) airport. PDRC uses trajectory-based takeoff time estimates from a surface automation system to improve en route tactical departure scheduling into constrained overhead flows. Controllers successfully used PDRC advisories to schedule actual DFW departures. Anecdotal feedback from these initial evaluations indicated that PDRC takeoff time estimates and en route departure schedules were usable and shows promise of providing the expected benefits.

Dynamic Airspace Configuration (DAC)

Dynamic airspace researchers continued to develop the Sector Combining Advisory Algorithm (SCAA) to aid air traffic control supervisors in determining when and where to combine airspace sectors into larger volumes. SCAA uses predictions of air traffic and available staffing levels to advise sector combinations. Initial simulation results showed that the algorithm can identify sector combinations that reduce congested airspace with only a small increase in sector reconfigurations. The algorithm will form the basis for OASIS (Operational Airspace and Staffing Integrated Scheduler).

The fifth in a series of Generic Airspace simulations was completed at Ames' CVSRF and the Pilot Simulation Laboratory in FFC. The simulation evaluated the Controller Information Tool, an auxiliary display that provides en route controllers with critical information on traffic flows, sector information, and special use airspace thus enabling future air traffic controllers to manage air traffic in NextGen airspace with reduced training.

Advanced Concepts Evaluation System (ACES)

Research using ACES, a simulation capability that is used to evaluate futuristic ATM concepts to understand their impact to the entire NAS, continued in FY11 to support analyses/evaluations of potential benefits of airspace partitioning with traffic flow management, precision departures, environmental impacts, tilt-rotor operations, and separation assurance. A workshop was hosted at Ames to share NASA's research experience with research and software development partners from other government organizations and industry. In addition, three additional external organizations began to use ACES.

NASA Research Announcements (NRA)

A number of NRA efforts were undertaken in FY11. These included traffic flow management (weather translation models for TFM), surface research (surface conflict detection and resolution), and dynamic airspace configuration (weather uncertainty, and designing and modifying airspace to manage airspace capacity to demand).

Other Accolades/Accomplishments

In addition to NASA awards, the division received several prestigious external awards:

- Yoon Jung, Ty Hoang, Justin Montoya, Gautam Gupta, Wakar Malik, Len Tobias, Hua Wang - Best Paper in the Airport track at the 2011 USA/Europe ATM R&D Seminar
- Karol "Bo" Bobko - inducted into the U.S. Astronaut Hall of Fame
- The FACET team - FAA Excellence in Aviation Research Award for 2010
- Patents awarded:
  - Russell Paielli - "Trajectory Specification for High-Capacity Air Traffic Control"
  - Banavar Sridhar, Kapil Sheth, Gano Chatterji, Karl Bilimoria, and Shon Grabbe - "Air Traffic Management Evaluation Tool" (for FACET development)
- Charles Schultz - 2nd place, Undergraduate Technical Paper category in the Region III AIAA Student Conference

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